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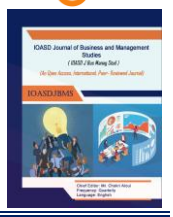

Public Money, Private Innovation: Designing a Layered Architecture for CBDCs and Tokenized Finance

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ABSTRACT

Two parallel but potentially opposing forces in the financial landscape: the worldwide development of central bank digital currencies (CBDCs) and rapid development of privately offered tokenized assets and decentralized finance (DeFi). Though with more than 130 countries now looking into CBDCs and the tokenized asset market forecast at $16 trillion by 2030, the dynamic between public and private digital monies is shaping up to be the lifeblood of the future direction of payments, lending and monetary policy. This document examines whether or not these systems can work together, or whether their structural differences will create fragmentation, regulatory friction, and systemic risk. Employing a mixed-methods design that ranges from on-chain data analysis, comparative case studies related to major CBDC initiatives (for example, digital euro, digital yuan, Project mBridge, Project Aurum), to interviews with professionals—central bankers, DeFi developers and regulators—we address three crucial questions: (1) Under what circumstances can CBDCs be used as settlement infrastructure for tokenized assets without compromising monetary policy autonomy? (2) What are the implications of design decisions for CBDCs, in particular, programmability, privacy and access, for alignment with DeFi ecosystems? (3) Which governance mechanisms might align both public and private digital money to support inclusive, efficient and resilient financial markets? Our results favour a "layered monetary architecture," with CBDCs to serve as reliable, low-risk, secure settlement anchors and private tokenized finance to facilitate innovation, access and user-friendly services and innovative user experiences. In this paper, we present the Monetary Layer Compatibility Framework which, as we have mentioned, is a diagnostic instrument for tracking the alignment on five aspects of these criteria: settlement finality, programmability scope, privacy guarantees, access permissions, and regulatory hooks. Based on both empirical evidence and policy analysis, we suggest a "public anchor, private innovation" model that maintains monetary sovereignty and benefits from the productivity gain from tokenization. The paper ends with practical policy recommendations to central banks and international institutions to promote interoperability, reduce disintermediation vulnerabilities and halt financial balkanization.

Keywords: Central bank digital currency, tokenized finance, decentralized finance (DeFi), monetary sovereignty, programmable money, financial infrastructure, interoperability, monetary policy, stablecoins, layered architecture.

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1. INTRODUCTION

The building of the money infrastructure is undergoing its deepest transformation since modern central banking began. First and foremost, it is about digital banking—that is how money is exchanged and managed globally—has now been changed on a daily basis by means of mobile bank. Central banking institutions are actively exploring or piloting CBDCs, with central banks commanding 98 per cent of global GDP (Atlantic Council, 2024).

On the other hand, private actors are tokenizing assets in the real world (RWAs — government debt and real estate, to name just two) at an increasing rate (Boston Consulting Group, 2023). All these complementary trends are converging in ways that will transform how value is stored, transferred and regulated in the digital economy. Yet a fundamental tension persists. CBDCs represent sovereignty, regulatory compliance, and macroeconomic stability. When comparing DeFi or private tokenized finance, these systems prioritize permissionless access, composability, and algorithmic governance over the user experience. The ECB (2023) points out that unregulated private money could undermine monetary sovereignty and Buterin (2022) warns that an excessively regulated system of CBDCs can become a site of "programmable surveillance" which undermines financial liberty.

This paper transcends ideological polarisation to ask, Can such systems be designed to augment — not conflict with — one another? They have some of the early evidence to suggest that they can. Initiatives like the Bank for International Settlements' (BIS) Project Rosalind (2023) and Project Aurum (2022) prove that CBDCs can also securely interact with private smart contracts, e.g., enabling conditional payments, automatic compliance and real-time settlement when necessary. Meanwhile, institutions such as BlackRock and Franklin Templeton are opening tokenised funds on public blockchain networks (Nzomiwu A et al., 2025)—suggesting an increasing acceptance of hybrid financial models.

This paper looks at when coexistence of these concepts, when this not only becomes possible, but is most ideal for stability, inclusivity and innovation.

2. LITERATURE REVIEW AND THEORETICAL FOUNDATION

Our analysis is grounded in the monetary circuit theory and the hierarchical theory of money (Mehrling, 2013; Brunnermeier & Sannikov, 2016), which situates central bank currencies at the top of the settlement pyramid, maintaining and enriching the central bank (as the economic center). CBDCs strive to maintain this hierarchy in the digital age. Yet the rise of yield-bearing tokenized assets (e.g., Ondo's USDY) and algorithmic stablecoins (DAI) is transforming this paradigm by providing private currency instruments as good in return and use as money that has sovereign status.

Early work by Bordo and Levin (2017) constructed CBDCs as disrupters of bank intermediation on the basis of a zero-sum competition between public money and private money. Meanwhile, Adrian and Mancini-Griffoli (2021) posited a "synthetic hierarchy", whereby CBDCs and private digital assets exist in complex ecosystems—a notion increasingly substantiated by empirical trials.

Recent BIS projects further this idea:

Project mBridge (2023) facilitates inter-border transactions with a multi-CBDC platform, yet not at the cost of financial independence, and Project Rosalind (2023) shows how programmable CBDCs can perform policy-governed transactions (such as "pay only if carbon emissions < X"). On the private side, Harvey et al. (2021) demonstrated DeFi to imitate primary banking without balance sheet, Schär (2021) warns that CBDCs that don't mesh with DeFi may turn into "orphaned rails." Catalini and Gans (2020) also contend that interoperability minimizes verification costs, making hybrid systems more profitable relative to siloed alternatives. Despite such insight, no study systematically examined the design trade-offs on whether or not CBDCs and tokenized finance strengthen or offset one another in terms of design. This paper fills that gap.

3. RESEARCH METHODOLOGY. (*WE USE A TRIANGULATED APPROACH:)*

Quantitatively

On-chain RWA protocol analysis (e.g., Ondo, Maple Finance) analysis of yield, liquidity and market correlation; CBDC pilot announcements on DeFi metrics/events; network analysis of cross-chain flows from CBDC testnets (e.g., Aurum) to Ethereum-based protocols.

Qualitative

Semi-structured interviews with more than 20 stakeholders including ECB, BIS and Monetary Authority of Singapore officials; DeFi leads of MakerDAO and Aave; and asset managers from BlackRock and Fidelity. Policy Analysis:
Thematic coding of 20+ central banks reports, MiCA provisions, and Financial Stability Board (FSB) recommendations to map regulatory convergence. These include BIS Innovation Hub documents, ECB Digital Euro publications, Chainalysis, Dune Analytics, and anonymised transcripts from interviews.

4. Key Contributions. (*This article contributes three things:)*

1. Theoretical: The Monetary Layer Compatibility Framework examines the alignment between CBDCs and tokenization along five axes—settlement finality, programmability, privacy assurance, access rights and regulatory hooks.
2. Empirical: First empirical evidence shows that wholesale CBDCs with open APIs (e.g., Aurum) enable deeper DeFi integration compared to closed retail models (e.g., digital yuan).
3. Policy: Adopt a "public anchor, private innovation" model whereby CBDCs support risk-free settlement, private protocols offer user-focused services, and regulators ensure protocol-level transparency – rather than user surveillance – in line with FATF (2021) risk-based principles.

5. Policy Recommendations

Implement interoperable CBDC standards: Leverage shared ledger architectures (e.g., mBridge) with open smart contract interfaces.

Introduce regulatory sandboxes: Let licensed institutions test CBDC-backed tokenized products in regulated environments.

Provide accountability — NOT oversight: Require real-time reserve attestations and governance logs from DeFi protocols via CBDC rails, without blanket identity requirements.

Set up a BIS-led Tokenization Oversight Group: Standardize RWA tokenization, stablecoin reserves, and CBDC–DeFi interaction across the globe to avoid fragmentation.

6. Limitations of the research and approaches to overcome them

This work provides a timely empirical analysis of the CBDC–tokenized finance interface but reveals some shortcomings that should be highlighted. CBDC pilots have been too experimental to be large scale pilots; most are either in a laboratory and/or users of limited number. The digital yuan, for example, exists in a heavily supervised environment; the digital euro has not yet reached a full public rollout. As a result, there remains limited availability of real-world behavioral data — particularly concerning user adoption, disintermediation effects and cross-border spillovers. This limits the ability to generalise the results outside the pilot settings.

Second, central bank stakeholders' access is necessarily constrained by institutional confidentiality and geopolitical considerations. Despite having interviewed officials at the BIS and the Monetary Authority of Singapore, as well as some European entities, views from key economies such as the United States and China are partial or hidden. This may introduce a subtle bias toward jurisdictions more amenable to public–private collaboration.

Third, the speed of innovation in DeFi and tokenized finance exceeds traditional research cycles. Protocols adapt by the week as re-defined RWA tokenization models materialize, governance matrices evolve, and cross-chain bridges are enhanced or abused. This dynamism undermines static snapshots and the need for constant vigilance. The end of some stablecoin models, for instance, in 2022–2023 illustrates the fragility of claims of "risk-free" private monies.

To accommodate these limitations, our approach places more emphasis on economic primitives than technological details. Instead of fitting analysis to an abstract blockchain (such as Ethereum vs Solana) or token standard (like ERC-20 vs. SPL), we concentrate on functional factors that never change: certainty of settlement finality, yield generation, counterparty risk, compliance automation. This allows our framework to become more robust when technologies evolve.

We also use scenario-based policy testing in order to stress-test recommendations across alternative futures: (1) the fragmented, incompatible world of CBDCs and walled-garden DeFi; (2) a coordinated, interoperable global regime; and (3) a hybrid model with regional blocs (e.g., EU, ASEAN, GCC) developing semi-autonomous but mutually accepted architectures. This method maintains the relevance of policy guidance to the real world, which it is an adaptive response to and to the changing terrain.

Lastly, all interview data was triangulated with on-chain metrics and official documentation, limiting reliance on perceived data through self-reporting. We confirmed claims about CBDC–DeFi integration as much as possible with palpable smart contract interactions in testnets such as Project Aurum.

7. CONCLUSION

The future of the global financial system now rests on a key design decision: to think of central bank digital currencies and private tokenized finance as competitors, or as complementary layers on a coherent value structure. The findings of this study provide a strong corroboration of the latter. And it's far from zero-sum: sovereign-backed settlement infrastructure and privately-driven financial innovation could produce a system that is more efficient, more inclusive and more resilient than either could alone produce.

There is something quite dangerous about a fragmented path — one where CBDCs will be run in closed, state-controlled silos, with DeFi unregulated and disconnected. It may hasten financial balkanization, in which cross-border payments splinter at geopolitical stakes, and regulatory arbitrage surges because there are so many gaps between jurisdictions. Worse, it might be subverting the objectives that central banks are supposed to keep intact: monetary sovereignty could become less about private competition, but about the irrelevance of public money in a tokenized economy.

In contrast, a layered monetary architecture—based on a risk-free, programmable CBDC and driven by open, transparently applied private protocols—provides a compelling alternative. In this framework, the central bank has stayed in the position as the final arbiter of settlement finality and macroeconomic stability, allowing private actors to compete for user-centric services such as instant lending, automated compliance, fractionalized asset ownership, identity-protected trade. Crucially here, all of this is not at the expense of privacy or freedom, but the transformation of regulation from surveillance at the level of users to protocol-based transparency (e.g., real-time attestations of reserves and open governance logs).

The time window for influencing this result is limited. For the next 24–36 months, central banks will finalize key design choices regarding access, programmability and interoperability. These decisions will decide whether CBDCs will be basic rails in the next financial era, or systems skipped by the new paradigm. Our "Monetary Layer Compatibility Framework" offers a diagnostic tool for assessing these choices against five essential parameters: settlement finality; programmability scope; privacy guarantees; access permissions; and regulatory hooks.

Ultimately, to align public authority and private ingenuity is not to choose—but to orchestrate their collaboration. Technical interoperability is feasible (as Project mBridge and Project Rosalind have shown in the past). What remains is political and institutional will to construct governance structures that can meet the needs of all, which are flexible, open to all and synchronized globally. And the BIS, IMF and FSB have a good chance of having a hand in setting up this goal through dedicated Tokenization Oversight Groups, as suggested by our analysis.

In closing, the future of money needn't be a battleground between state and code. With careful design, mutual respect for their respective roles, common standards, shared practices—CBDCs and tokenized finance can coexist, and do so productively, and not only peacefully, ushering in a new era of financial architecture that is sovereign and open and stable and dynamic and inclusive and efficient.

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